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EXAMINER	
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1795	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/824,719	SCHUBERT ET AL.	
	Examiner	**Art Unit**	
	Tony Chuo	1795	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 29 June 2009.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-11,13-24 and 38-49 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-11,13-24 and 38-49 is/are rejected.

7)☒ Claim(s) 13 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 6/1/09 has been entered.

Response to Amendment

2. Claims 1-11, 13-24, and 38-49 are currently pending. Claims 12 and 25-37 are cancelled. New claims 41-49 have been added. The amended claims do overcome the previously stated 112 and 103 rejections. However, upon further consideration, claims 1-11, 13-24, and 38-49 are rejected under the following new 112 and 103 rejections.

Claim Objections

3. Claim 13 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claim 13 depends on

cancelled claim 12. For purpose of compact prosecution, claim 13 is construed as depending on claim 8.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

5. Claim 41 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The limitation "wherein said interior surfaces of said porous silicon has feature sizes of about one nanometer" is not supported by the specification. Paragraph [0071] of the specification describes the feature size of silicon column that should be on the order of 1 nanometer. However, this paragraph does not describe interior surfaces of porous silicon that has feature sizes of about one nanometer.

6. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

7. Claim 41 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant

regards as the invention. It is unclear what features of the interior surface of the porous surface have sizes of about one nanometer.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. Claims 1, 3-5, 19-24, 38, 39, and 42-45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Redmond (US 2004/0016769) in view of Winstel (US 4265720) and Northrup et al (US 5882496), and further in view of Zaluska et al (US 5882623) and as evidenced by Woo et al (US 5926711).

The Redmond reference discloses a hydrogen storage and recovery system "100" comprising a cassette "110" (housing); an opening connected to the cassette for conducting hydrogen gas into and conducting hydrogen gas out of the housing; a hydrogen storing material "115" enclosed within the cassette; a heating system for releasing hydrogen from the hydrogen storing material from the cassette through the opening; and an information processing and control system that is used to control or regulate hydrogen generation that includes sensors that sense the operating conditions of the system and adjusts the conditions within the cassette such as increasing the amount of heat supplied to the cassette in order to achieve an elevated temperature in the cassette and an increased release of hydrogen gas (See paragraphs [0044],[0064],

[0073],[0080]). Examiner's note: According to the specification of the present application, "The silicon activation energies, i.e., the adsorption and desorption energies of hydrogen on silicon, must also be controlled. This is accomplished through one or more techniques comprising … temperature activation …". In other words, by controlling the temperature of the hydrogen storing material, the silicon activation energy is also inherently controlled. Therefore, the control system and heating system taught by Redmond implicitly controls the activation energy of hydrogen by controlling the temperature of the hydrogen storing material. In addition, the heating system is an equivalent structure for causing the chemisorbed hydrogen atoms to be liberated from the dangling bond sites to be released as hydrogen gas from the housing through the at least one passage.

However, Redmond does not expressly teach a hydrogen storage member comprising a mass of silicon, wherein the silicon is in a monocrystalline form or a polycrystalline form. The Winstel reference discloses a hydrogen storage material that is a silicon material that is in a finely crystalline form (See column 1, lines 40-47). Examiner's note: It is well known in the art that crystalline silicon can be formed in a monocrystalline form or polycrystalline form.

Therefore, the invention as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made because the disclosure of Winstel indicates that crystalline silicon is a suitable material for use as a hydrogen storage material. The selection of a known material based on its suitability for its intended use

has generally been held to be *prima facie* obvious (MPEP §2144.07). As such, it would be obvious to use crystalline silicon.

However, Redmond as modified by Winstel does not expressly teach a porous silicon having interior and exterior surfaces, wherein at least the interior surfaces have dangling bond sites at which reversible chemisorption of hydrogen atoms occurs, wherein at least the interior surfaces of the porous silicon have dendritic spikes or etched pits, wherein at least interior surfaces are bare silicon surfaces at which the dangling bond sites are exposed, wherein the porous silicon has been treated by a process selected from the group consisting of crushing, milling, treatment with hydrofluoric acid and methanol in the presence of electric current, treatment with potassium hydroxide, treatment with hydrazine, wet etching, dry etching, deposition of a noble metal such as palladium or platinum, conformal vapor deposition of silicon, and non-conformal vapor deposition of silicon, wherein the porous silicon is derived from molten silicon by crystallization, and wherein the porous silicon is derived from silicon waste obtained from a silicon process waste stream.

The Northrup reference discloses a porous silicon structure that is formed by electrochemically etching a crystalline silicon substrate or wafer "10" with a hydrogen fluoride solution (wet etching), wherein the porous silicon adsorbs gas and desorbs gas upon increase in temperature by a heater (releasing means), and wherein the porous silicon is formed on a silicon wafer (See column 3, lines 43-64 and column 4, lines 50-52). Examiner's note: The process of etching the surface of the silicon layer inherently forms interior and exterior surfaces, wherein pores (etched pits) formed have interior

surfaces that are bare silicon surfaces. It is also inherent that the porous silicon defines a layer within at least a first surface portion of the hydrogen storage member. In addition, as evidenced by Woo et al, the process of wet etching the surface of a silicon film with HF, cleans the surface of the silicon film to form a bare silicon surface such that hydrogen bonds to the surface of the silicon film in dangling bond type (See column 4, lines 20-28). Further, it is noted that claims 23 and 24 are being construed as product-by-process and that the product itself does not depend on the process of making it. Accordingly, in a product-by-process claim, the patentability of a product does not depend on its method of production. The claims are obvious as it has been held similar products claimed in product-by-process limitations are obvious (In re Brown 173 USPQ 685 and In re Fessman 180 USPQ 324, See MPEP 2113: Product-by-Process claims).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Redmond/Winstel hydrogen storage material to include a porous silicon having interior and exterior surfaces, wherein at least the interior surfaces have dangling bond sites at which reversible chemisorption of hydrogen atoms occurs, wherein at least the interior surfaces of the porous silicon have etched pits, wherein at least interior surfaces are bare silicon surfaces at which the dangling bond sites are exposed, wherein the porous silicon has been treated by a process such as wet etching in order to utilize a high surface area porous silicon structure that significantly augments the adsorption and desorption of gases (See Abstract).

However, Redmond as modified by Winstel and Northrup et al does not expressly teach a releasing means that is selected from the group consisting of light sources, current sources, voltage sources, and combinations thereof. The Zaluska reference teaches a method of initiating hydrogen release and inducing hydrogen desorption using non-thermal energy sources such as flowing current through a hydrogen storage material (current source) and using radiation produced by high intensity light sources (See column 2 line 65 to column 3 line 10 and column 3, lines 54-56). Examiner's note: It is inherent that using radiation produced by high intensity light source would pass photonic energy through the hydrogen storage material (porous silicon). In addition, although Zaluska et al discloses methods of inducing hydrogen desorption for a metal hydride, one of ordinary skill in the art would envisage utilizing the same methods for other known hydrogen storage materials such as porous silicon.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to substitute the Redmond/Winstel/Northrup method of releasing hydrogen with a releasing means that is a light source or current source because the substitution of one known method of initiating hydrogen desorption for another would have yielded predictable results to one of ordinary skill in the art at the time of the invention.

10. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Redmond (US 2004/0016769) in view of Winstel (US 4265720), Northrup et al (US 5882496), and Zaluska et al (US 5882623) as applied to claim 1 above, and further in view of Gore et al (US 2004/0048466).

However, Redmond as modified by Winstel, Northrup, and Zaluska does not expressly teach at least the interior surfaces of the porous silicon that have dendritic spikes. The Gore reference discloses a process of creating a textured silicon surface with surface features having at least one of various shapes including spikes (See paragraph [0009].

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Redmond/Winstel/Northrup hydrogen storage material to include at least the interior surfaces of the porous silicon that have dendritic spikes in order to further increase the storage capacity of hydrogen by increasing the surface area of the porous silicon (See Abstract).

11. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Redmond (US 2004/0016769) in view of Winstel (US 4265720), Northrup et al (US 5882496), and Zaluska et al (US 5882623) as applied to claims 1 and 5 above.

However, Redmond as modified by Winstel and Northrup et al does not expressly teach a percent void volume of the surface layer that is about 50%.

However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Winstel/Northrup porous silicon structures to include a percent void volume of the surface layer that is about 50% because it has been held that the discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art. *In re Boesch*, 205 USPQ 215 (CCPA 1980). The percent void volume is a result effective variable of increasing the

surface area of the porous silicon structure. In addition, there is no evidence of the criticality of the percent void volume.

12. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Redmond (US 2004/0016769) in view of Winstel (US 4265720), Northrup et al (US 5882496), and Zaluska et al (US 5882623) as applied to claims 1 and 5 above, and further in view of Wagner et al (US 5196377).

However, Redmond as modified by Winstel, Northrup et al, and Zaluska et al does not expressly teach electronic integrated circuits on a second surface portion of the hydrogen storage member. The Wagner reference discloses integrated circuits that are placed inside cavities of a silicon wafer "10" (See column 11, lines 12-16).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Redmond/Winstel/Northrup/Zaluska porous silicon structures to include electronic integrated circuits on a second surface portion of the hydrogen storage member in order to utilize well known integrated circuit processing techniques to provide a silicon water-based integrated circuit carrier offering high density packaging with high yield processes. In addition, one skilled in the art could have combined the elements as claimed by known methods with no change in their respective functions, and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art at the time of the invention.

13. Claims 8 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Winstel (US 4265720) in view of Kornilovich (US 7135057), and further in view of Northrup et al (US 5882496), and as evidenced by Woo et al (US 5926711).

The Winstel reference discloses a system for storing and retrieving hydrogen comprising: a housing “4”; a passage connected to the housing for conducting hydrogen gas into and conducting hydrogen gas out of the housing; a hydrogen storage member “5” enclosed within the housing that is a silicon material in a finely crystalline form; an operative valve control means “6”; and implicitly a heating means for discharging hydrogen gas from the housing through the passage (See column 2, lines 63-67, column 3, lines 40-48, and Figure 2). Examiner’s note: The valve “6” and heating means disclosed by Winstel are construed as an equivalent structure for liberating chemisorbed hydrogen atoms from the dangling bond sites and releasing the liberated hydrogen atoms as hydrogen gas.

However, Winstel does not expressly teach a hydrogen storage member comprising a porous mesh of silicon columns, wherein the silicon columns are extruded through at least one aperture that is an integral multiple of the lattice spacing of silicon such that the silicon columns have a minimum energy configuration suitable for forming a crystal, wherein the silicon columns have cross-sectional shapes of a circle. The Kornilovich reference teaches a hydrogen storage medium that is made of a large pile of silicon nanowires that are in the shape of a column having cross-sectional shape of a circle such that the hydrogen storage medium has porosity (See column 3, lines 27-31). In addition, it also discloses that the storage efficiency of the hydrogen storage medium improves with decreasing nanowire radius (silicon column diameter) (See column 3, lines 31-33).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Winstel system for storing and retrieving hydrogen to include a hydrogen storage member comprising a porous mesh of silicon columns, wherein the silicon columns are extruded through at least one aperture that is an integral multiple of the lattice spacing of silicon such that the silicon columns have a minimum energy configuration suitable for forming a crystal in order to improve the storage efficiency of the hydrogen storage medium and to allow fast diffusion of gas molecules such as hydrogen gas. In addition, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Winstel/Kornilovich hydrogen storage medium to include silicon columns having diameters of about 1 nanometer because it has been held that the discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art. *In re Boesch*, 205 USPQ 215 (CCPA 1980). The diameter of the silicon column is a result effective variable of increasing the storage efficiency of silicon columns because the smaller the diameter of the silicon column, the larger the overall surface area of the storage medium.

However, Winstel as modified by Kornilovich does not expressly teach a hydrogen storage member comprising a silicon material having silicon surfaces with dangling bond sites at which reversible chemisorption of hydrogen atoms occurs. The Northrup reference discloses a porous silicon structure that is formed by electrochemically etching a crystalline silicon substrate or wafer “10” with a hydrogen fluoride solution (See column 3, lines 61-64 and column 4, lines 50-52). Examiner’s

note: As evidenced by Woo et al, the process of wet etching the surface of a silicon film with HF, cleans the surface of the silicon film to form a bare silicon surface such that hydrogen bonds to the surface of the silicon film in dangling bond type (See column 2 line 65 to column 3 line 2).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Winstel/Kornilovich system for storing and retrieving hydrogen to include a hydrogen storage member comprising a silicon having surfaces with dangling bond sites at which reversible chemisorption of hydrogen atoms occurs in order to increase the surface area of the silicon columns, thereby significantly augmenting the adsorption and desorption of the hydrogen gas.

14. Claims 9-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Winstel (US 4265720) in view of Kornilovich (US 7135057) and Northrup et al (US 5882496) and as evidenced by Woo et al (US 5926711) as applied to claim 8 above, and further in view of Kim (US 2002/0158284).

However, Winstel as modified by Kornilovich and Northrup et al does not expressly teach silicon columns that are formed by extrusion of molten silicon to have surfaces on the (111) plane. The Kim reference discloses that typically silicon wafers have a (100) orientation on the top surface and the exposed silicon near the trenches has a (111) orientation, wherein the (111) orientation has a larger number of dangling bonds (See paragraph [0006]). Examiner's note: It is noted that claims 10 and 11 are being construed as product-by-process and that the product itself does not depend on the process of making it. Accordingly, in a product-by-process claim, the patentability of

a product does not depend on its method of production. The claims are obvious as it has been held similar products claimed in product-by-process limitations are obvious (In re Brown 173 USPQ 685 and In re Fessman 180 USPQ 324, See MPEP 2113: Product-by-Process claims).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Winstel/Kornilovich/Northrup system for storing and retrieving hydrogen to include silicon columns that are formed by extrusion of molten silicon to have surfaces on the (111) plane in order to utilize a silicon material orientation that has a greater number of dangling bonds, thereby increasing the storage efficiency of the hydrogen storage material.

15. Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Winstel (US 4265720) in view of Kornilovich (US 7135057), Northrup et al (US 5882496), and Kim (US 2002/0158284) as applied to claim 10 above, and further in view of Anthony et al (US 6040230).

However, Winstel as modified by Kornilovich, Northrup et al, and Kim does not expressly teach silicon columns that have roughened surface. The Anthony reference discloses polysilicon structures "306" that etched with oxygen in order to roughen the surface (See column 6, lines 6-10).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Winstel/Kornilovich/Northrup/Kim system for storing and retrieving hydrogen to include silicon columns that have roughened surface

in order to enhance the surface area of the silicon columns and further improve the storage efficiency.

16. Claims 15 and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Winstel (US 4265720) in view of Kornilovich (US 7135057) and Northrup et al (US 5882496) applied to claim 8 above, and further in view of Redmond (US 2004/ 0016769).

However, Winstel as modified by Kornilovich and Northrup et al does not expressly teach a control unit comprising means for receiving inputs indicative of operating parameters of the system and means for issuing outputs that control the liberating means, wherein the control unit comprises means for controlling the silicon activation energy of hydrogen on the porous mesh of crystalline silicon columns of the hydrogen storage member. The Redmond reference discloses a hydrogen storage and recovery system "100" comprising an information processing and control system that is used to control or regulate hydrogen generation that includes sensors that sense the operating conditions of the system and adjusts the conditions within the cassette such as increasing the amount of heat supplied to the cassette in order to achieve an elevated temperature in the cassette and an increased release of hydrogen gas (See paragraphs [0044],[0064], [0073],[0080]). Examiner's note: According to the specification of the present application, "The silicon activation energies, i.e., the adsorption and desorption energies of hydrogen on silicon, must also be controlled. This is accomplished through one or more techniques comprising ... temperature activation ...". In other words, by controlling the temperature of the hydrogen storing

material, the silicon activation energy is also inherently controlled. Therefore, the control system and heating system taught by Redmond implicitly controls the activation energy of hydrogen by controlling the temperature of the hydrogen storing material.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Winstel/Kornilovich/Northrup system for storing and retrieving hydrogen to include a control unit comprising means for receiving inputs indicative of operating parameters of the system and means for issuing outputs that control the liberating means, wherein the control unit comprises means for controlling the silicon activation energy of hydrogen on the porous mesh of crystalline silicon columns of the hydrogen storage member in order to utilize a control system that more accurately and efficiently supplies hydrogen to a hydrogen utilizing system.

17. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Winstel (US 4265720) in view of Kornilovich (US 7135057), Northrup et al (US 5882496), and Redmond (US 2004/ 0016769) as applied to claim 15 above, and further in view of Zaluska et al (US 5882623).

However, Winstel as modified by Kornilovich and Northrup et al does not expressly teach a releasing means that is selected from the group consisting of light sources, current sources, voltage sources, and combinations thereof, wherein the liberating means liberates chemisorbed hydrogen atoms from the dangling bond sites by passing photonic energy through the porous mesh, passing current through the porous mesh, or creating an electrical field across the porous mesh. The Zaluska reference teaches a method of initiating hydrogen release and inducing hydrogen

desorption using non-thermal energy sources such as flowing current through a hydrogen storage material (current source) and using radiation produced by high intensity light sources (See column 2 line 65 to column 3 line 10 and column 3, lines 54-56). Examiner's note: It is inherent that using radiation produced by high intensity light source would pass photonic energy through the hydrogen storage material (porous silicon). In addition, although Zaluska et al discloses methods of inducing hydrogen desorption for a metal hydride, one of ordinary skill in the art would envisage utilizing the same methods for other known hydrogen storage materials such as porous silicon.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to substitute the Winstel/Kornilovich/Northrup/Redmond method of releasing hydrogen with a liberating means that is a light source or current source, wherein the liberating means liberates chemisorbed hydrogen atoms from the dangling bond sites by passing photonic energy through the porous mesh, passing current through the porous mesh because the substitution of one known method of initiating hydrogen desorption for another would have yielded predictable results to one of ordinary skill in the art at the time of the invention.

18. Claims 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Redmond (US 2004/0016769) in view of Winstel (US 4265720), Northrup et al (US 5882496), and Zaluska et al (US 5882623) as applied to claim 1 above, and further in view of Ota et al (US 6540377).

However, Redmond as modified by Winstel, Northrup et al, and Zaluska et al does not expressly teach a releasing means comprising a light emitting diode or a light

source that emits photon energy at a wavelength of about 660 nanometers. The Ota reference teaches a light source that is a red light emitting diode which is a light source that inherently emits photon energy at a wavelength of about 660 nanometer (See Abstract).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Redmond/Winstel/Northrup/Zaluska fuel cell system to include a releasing means comprising a light emitting diode or a light source that emits photon energy at a wavelength of about 660 nanometers because the substitution of one known type of light source for another would have yielded predictable results to one of ordinary skill in the art at the time of the invention. In addition, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Redmond/Winstel/Northrup/Zaluska fuel cell system to include a releasing means comprising a light source that emits photon energy at a wavelength of about 660 nanometers because it has been held that the discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980). Where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover optimum or workable ranges by routine experimentation (*In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955)). The wavelength of the light source is recognized in the art as a results effective variable for causing hydrogen atoms to be liberated from a silicon material.

19. Claim 46 is rejected under 35 U.S.C. 103(a) as being unpatentable over Redmond (US 2004/0016769) in view of Winstel (US 4265720), Northrup et al (US 5882496), and Zaluska et al (US 5882623) as applied to claim 1 above, and further in view of Yamazaki et al (US 6964890).

However, Redmond as modified by Winstel, Northrup et al, and Zaluska et al does not expressly teach a releasing means comprising a voltage source that liberates the chemisorbed hydrogen atoms form the dangling bond sites by creating an electric field across the porous silicon. The Yamazaki reference teaches that the bond between hydrogen and a semiconductor element such as silicon is generally weak and would easily undergo breakage. It also discloses that when electric voltage or current is applied, hydrogen readily undergoes desorption (See column 2, lines 38-45).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Redmond/Winstel/Northrup/Zaluska fuel cell system to include a releasing means comprising a voltage source that liberates the chemisorbed hydrogen atoms form the dangling bond sites by creating an electric field across the porous silicon because the substitution of one known method of initiating hydrogen desorption for another would have yielded predictable results to one of ordinary skill in the art at the time of the invention.

20. Claims 47 and 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Winstel (US 4265720) in view of Kornilovich (US 7135057) and Northrup et al (US 5882496) as applied to claim 8 above, and further in view of Zaluska et al (US 5882623).

However, Winstel as modified by Kornilovich and Northrup et al does not expressly teach a liberating means that comprises a light source that liberates the chemisorbed hydrogen atoms from the dangling bond sites by passing photonic energy through the porous mesh or a current source that liberates the chemisorbed hydrogen atoms from the dangling bond sites by passing electrical current through the porous mesh. The Zaluska reference teaches a method of initiating hydrogen release and inducing hydrogen desorption using non-thermal energy sources such as flowing current through a hydrogen storage material (current source) and using radiation produced by high intensity light sources (See column 2 line 65 to column 3 line 10 and column 3, lines 54-56). Examiner's note: It is inherent that using radiation produced by high intensity light source would pass photonic energy through the hydrogen storage material (porous silicon). In addition, although Zaluska et al discloses methods of inducing hydrogen desorption for a metal hydride, one of ordinary skill in the art would envisage utilizing the same methods for other known hydrogen storage materials such as porous silicon.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the Winstel/Kornilovich/Northrup fuel cell system to include a releasing means that is a light source that liberates the chemisorbed hydrogen atoms from the dangling bond sites by passing photonic energy through the porous mesh or a current source that liberates the chemisorbed hydrogen atoms from the dangling bond sites by passing electrical current through the porous mesh because the substitution of one known method of initiating hydrogen desorption for another

would have yielded predictable results to one of ordinary skill in the art at the time of the invention.

21. Claim 49 is rejected under 35 U.S.C. 103(a) as being unpatentable over Winstel (US 4265720) in view of Kornilovich (US 7135057) and Northrup et al (US 5882496) as applied to claim 8 above, and further in view of Yamazaki et al (US 6964890).

However, Winstel as modified by Kornilovich and Northrup et al does not expressly teach a liberating means comprising a voltage source that liberates the chemisorbed hydrogen atoms form the dangling bond sites by creating an electric field across the porous mesh. The Yamazaki reference teaches that the bond between hydrogen and a semiconductor element such as silicon is generally weak and would easily undergo breakage. It also discloses that when electric voltage or current is applied, hydrogen readily undergoes desorption (See column 2, lines 38-45).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Redmond/Winstel/Northrup/Zaluska fuel cell system to include a liberating means comprising a voltage source that liberates the chemisorbed hydrogen atoms form the dangling bond sites by creating an electric field across the porous mesh because the substitution of one known method of initiating hydrogen desorption for another would have yielded predictable results to one of ordinary skill in the art at the time of the invention.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tony Chuo whose telephone number is (571)272-0717. The examiner can normally be reached on M-F, 9:00AM to 5:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on (571) 272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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TC

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